Allied Telesis

AlliedWare™ OS

How To | Configure EPSR (Ethernet Protection Switching Ring) to Protect a Ring from Loops

Introduction

Putting a ring of Ethernet switches at the core of a network is a simple way to increase the network's resilience—such a network is no longer susceptible to a single point of failure. However, the ring must be protected from Layer 2 loops. Traditionally, STP-based technologies are used to protect rings, but they are relatively slow to recover from link failure. This can create problems for applications that have strict loss requirements, such as voice and video traffic, where the speed of recovery is highly significant.

This How To Note describes a fast alternative to STP: Ethernet Protection Switching Ring (EPSR). EPSR enables rings to recover rapidly from link or node failures—within as little as 50ms, depending on port type and configuration. This is much faster than STP at 30 seconds or even RSTP at 1 to 3 seconds.

What information will you find in this document?

This How To Note begins by describing EPSR in the following sections:

- "How EPSR Works" on page 3
- "Establishing a Ring" on page 4
- "Detecting a Fault" on page 5
- "Recovering from a Fault" on page 5
- "Restoring Normal Operation" on page 7

Next it gives step-by-step configuration details and examples in the following sections:

- "How To Configure EPSR" on page 8
- "Example 1: A Basic Ring" on page 11
- "Example 2: A Double Ring" on page 14

- "Example 3: EPSR and RSTP" on page 17
- "Example 4: EPSR with Nested VLANs" on page 20
- "Example 5: EPSR with management stacking" on page 23
- "Example 6: EPSR with an iMAP" on page 26

Next, it discusses important implementation details in the following sections:

- "Classifiers and Hardware Filters" on page 29
- "Ports and Recovery Times" on page 30
- "IGMP Snooping and Recovery Times" on page 31
- "Health Message Priority" on page 31

Finally, it ends with troubleshooting information in the following sections:

- "EPSR State and Settings" on page 32
- "SNMP Traps" on page 34
- "Counters" on page 35
- "Debugging" on page 36

Which products and software versions does it apply to?

This How To Note applies to the following Allied Telesis switches:

- AT-8948, x900-48FE, x900-48FE-N, AT-9924T, AT-9924SP, and AT-9924T/4SP switches, running software version 2.8.1 or later
- AT-9924Ts, x900-24XT, and x900-24XT-N switches running software version 3.1.1 or later

EPSR is also available on the following Allied Telesis switches, running the AlliedWare Plus OS software version 5.2.1 or later:

- SwitchBlade x908
- x900 series

For information about using the AlliedWare Plus OS, see the AlliedWare Plus Note, *How To Configure EPSR (Ethernet Protection Switching Ring) to Protect a Ring from Loops*. This Note is available from www.alliedtelesis.com/resources/literature/howto_plus.aspx.

The implementation on the above switches is also compatible with EPSR on Allied Telesis' Multiservice Access Platforms (iMAPs).

How EPSR Works

EPSR operates on physical rings of switches (note, not on meshed networks). When all nodes and links in the ring are up, EPSR prevents a loop by blocking data transmission across one port. When a node or link fails, EPSR detects the failure rapidly and responds by unblocking the blocked port so that data can flow around the ring.

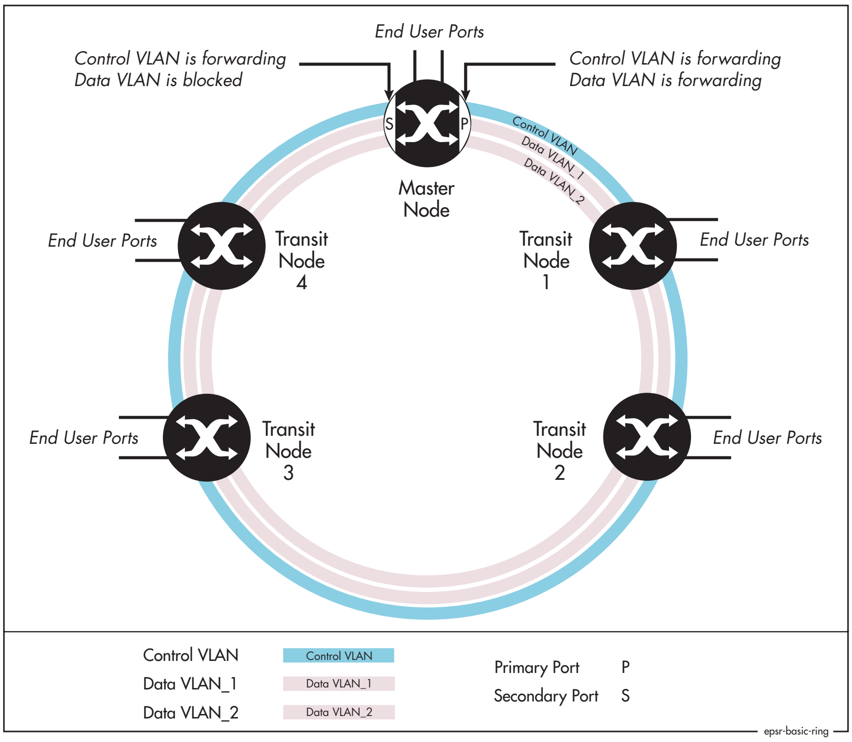
In EPSR, each ring of switches forms an **EPSR domain**. One of the domain's switches is the **master node** and the others are **transit nodes**. Each node connects to the ring via two ports.

One or more **data VLANs** sends data around the ring, and a **control VLAN** sends EPSR messages. A physical ring can have more than one EPSR domain, but each domain operates as a separate logical group of VLANs and has its own control VLAN and master node.

On the master node, one port is the **primary port** and the other is the **secondary port**. When all the nodes in the ring are up, EPSR prevents loops by blocking the data VLAN on the secondary port.

The master node does not need to block any port on the control VLAN because loops never form on the control VLAN. This is because the master node never forwards any EPSR messages that it receives.

The following diagram shows a basic ring with all the switches in the ring up.



EPSR Components

EPSR domain:

A protection scheme for an Ethernet ring that consists of one or more data VLANs and a control VLAN.

Master node:

The controlling node for a domain, responsible for polling the ring state, collecting error messages, and controlling the flow of traffic in the domain.

Transit node:

Other nodes in the domain.

Ring port:

A port that connects the node to the ring. On the master node, each ring port is either the primary port or the secondary port. On transit nodes, ring ports do not have roles.

Primary port:

A ring port on the master node. This port determines the direction of the traffic flow, and is always operational.

Secondary port:

A second ring port on the master node. This port remains active, but blocks all protected VLANs from operating unless the ring fails. Similar to the blocking port in an STP/RSTP instance.

Control VLAN:

The VLAN over which all control messages are sent and received. EPSR never blocks this VLAN.

Data VLAN

A VLAN that needs to be protected from loops. Each EPSR domain has one or more data VLANs.

Establishing a Ring

Once you have configured EPSR on the switches, the following steps complete the EPSR ring:

1. The master node creates an EPSR **Health** message and sends it out the primary port. This increments the master node’s **Transmit: Health** counter in the **show epsr count** command.

2. The first transit node receives the Health message on one of its two ring ports and, using a hardware filter, sends the message out its other ring port.

   Note that transit nodes never generate Health messages, only receive them and forward them with their switching hardware. This does not increment the transit node’s Transmit: Health counter. However, it does increment the Transmit counter in the **show switch port** command.

   The hardware filter also copies the Health message to the CPU. This increments the transit node’s **Receive: Health** counter. The CPU processes this message as required by the state machines, but does not send the message anywhere because the switching hardware has already done this.

3. The Health message continues around the rest of the transit nodes, being copied to the CPU and forwarded in the switching hardware.

4. The master node eventually receives the Health message on its secondary port. The master node's hardware filter copies the packet to the CPU (which increments the master node’s Receive: Health counter). Because the master received the Health message on its secondary port, it knows that all links and nodes in the ring are up.

   When the master node receives the Health message back on its secondary port, it resets the Failover timer. If the Failover timer expires before the master node receives the Health message back, it concludes that the ring must be broken.

   Note that the master node does not send that particular Health message out again. If it did, the packet would be continuously flooded around the ring. Instead, the master node generates a new Health message when the Hello timer expires.

Detecting a Fault

EPSR uses a fault detection scheme that alerts the ring when a break occurs, instead of using a spanning tree-like calculation to determine the best path. The ring then automatically heals itself by sending traffic over a protected reverse path.

EPSR uses the following two methods to detect when a transit node or a link goes down:

- Master node polling fault detection

  To check the condition of the ring, the master node regularly sends Health messages out its primary port, as described in "Establishing a Ring" on page 4. If all links and nodes in the ring are up, the messages arrive back at the master node on its secondary port.

  This can be a relatively slow detection method, because it depends on how often the node sends Health messages.

  Note that the master node only ever sends Health messages out its primary port. If its primary port goes down, it does not send Health messages.

- Transit node unsolicited fault detection

  To speed up fault detection, EPSR transit nodes directly communicate when one of their interfaces goes down. When a transit node detects a fault at one of its interfaces, it immediately sends a Link-Down message over the link that remains up. This notifies the master node that the ring is broken and causes it to respond immediately.

Master Node States

Complete:

The state when there are no link or node failures on the ring.

Failed:

The state when there is a link or node failure on the ring. This state indicates that the master node received a Link-Down message or that the failover timer expired before the master node's secondary port received a Health message.

Transit Node States

Idle:

The state when EPSR is first configured, before the master node determines that all links in the ring are up. In this state, both ports on the node are blocked for the data VLAN. From this state, the node can move to Links Up or Links Down.

Links Up:

The state when both the node's ring ports are up and forwarding. From this state, the node can move to Links Down.

Links Down:

The state when one or both of the node's ring ports are down. From this state, the node can move to Pre-forwarding

Pre-forwarding:

The state when both ring ports are up, but one has only just come up and is still blocked to prevent loops. From this state, the transit node can move to Links Up if the master node blocks its secondary port, or to Links Down if another port goes down.

Recovering from a Fault

Fault in a link or a transit node

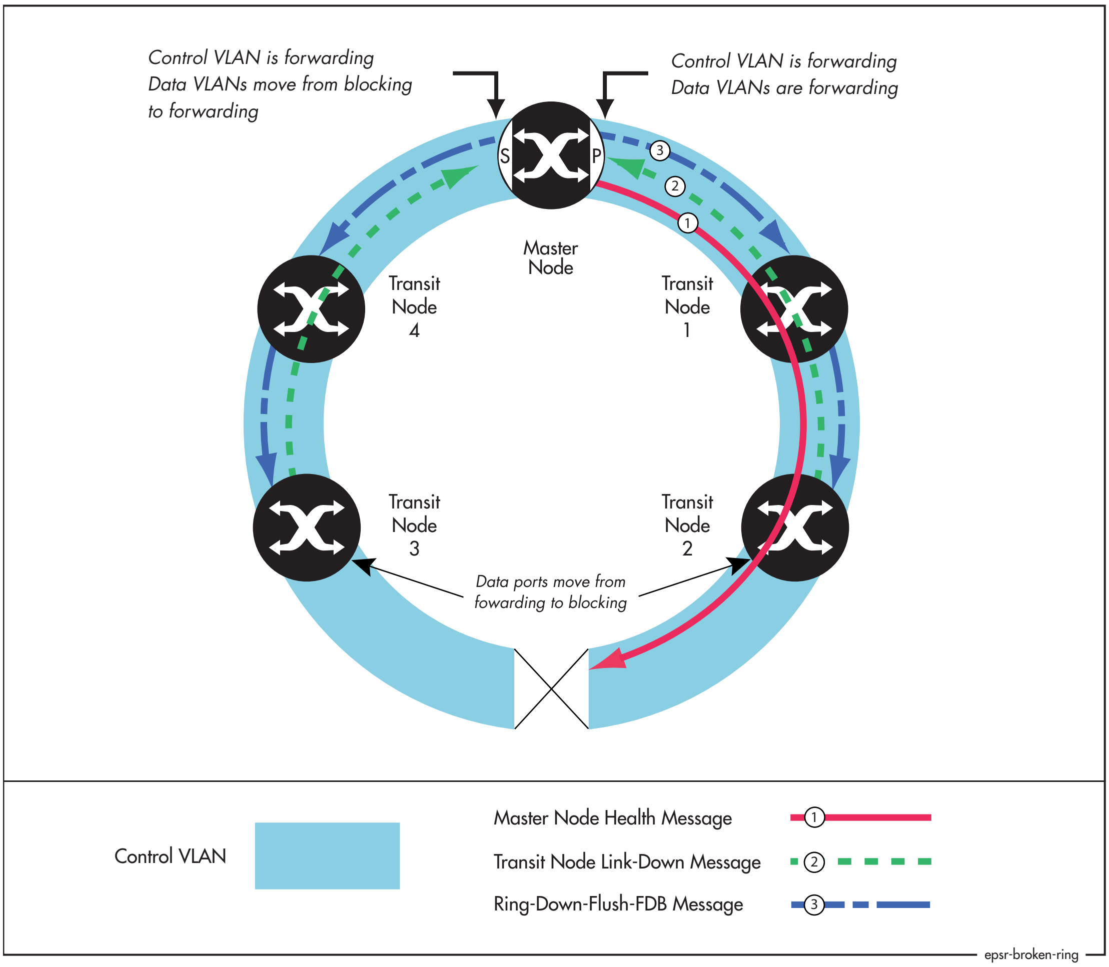
When the master node detects an outage somewhere in the ring, using either detection method, it restores traffic flow by:

1. declaring the ring to be in a **Failed** state
2. unblocking its secondary port, which enables data VLAN traffic to pass between its primary and secondary ports
3. flushing its own forwarding database (FDB) for the two ring ports
4. sending an EPSR **Ring-Down-Flush-FDB** control message to all the transit nodes, via both its primary and secondary ports

   The transit nodes respond to the Ring-Down-Flush-FDB message by flushing their forwarding databases for each of their ring ports. As the data starts to flow in the ring's new configuration, the nodes (master and transit) re-learn their layer 2 addresses. During this period, the master node continues to send Health messages over the control VLAN. This situation continues until the faulty link or node is repaired.

For a multidomain ring, this process occurs separately for each domain within the ring.

The following figure shows the flow of control frames when a link breaks.


Control VLAN is forwarding
Data VLANs move from blocking to forwarding
Control VLAN is forwarding
Data VLANs are forwarding
S
P
Master Node
Transit Node 4
Transit Node 1
Transit Node 3
Transit Node 2
1
2
3
Data ports move from fowarding to blocking
Control VLAN
Master Node Health Message
Transit Node Link-Down Message
Ring-Down-Flush-FDB Message
epsr-broken-ring

Fault in the master node

If the master node goes down, the transit nodes simply continue forwarding traffic around the ring—their operation does not change.

The only observable effects on the transit nodes are that:

- They stop receiving Health messages and other messages from the master node.
- The transit nodes connected to the master node experience a broken link, so they send Link-Down messages. If the master node is down these messages are simply dropped.

Neither of these symptoms affect how the transit nodes forward traffic.

Once the master node recovers, it continues its function as the master node.

Restoring Normal Operation

Master Node

Once the fault has been fixed, the master node's Health messages traverse the whole ring and arrive at the master node's secondary port. The master node then restores normal conditions by:

1. declaring the ring to be in a state of **Complete**
2. blocking its secondary port for data VLAN traffic (but not for the control VLAN)
3. flushing its forwarding database for its two ring ports
4. sending a Ring-Up-Flush-FDB message from its primary port, to all transit nodes.

Transit Nodes with One Port Down

As soon as the fault has been fixed, the transit nodes on each side of the (previously) faulty link section detect that link connectivity has returned. They change their ring port state from Links Down to Pre-Forwarding, and wait for the master node to send a Ring-Up-Flush-FDB control message.

Once these transit nodes receive the Ring-Up-Flush-FDB message, they:

- flush the forwarding databases for both their ring ports
- change the state of their ports from blocking to forwarding for the data VLAN, which allows data to flow through their previously-blocked ring ports

The transit nodes do not start forwarding traffic on the previously-down ports until after they receive the Ring-Up-Flush-FDB message. This makes sure the previously-down transit node ports stay blocked until after the master node blocks its secondary port. Otherwise, the ring could form a loop because it had no blocked ports.

Transit Nodes with Both Ports Down

The Allied Telesis implementation includes an extra feature to improve handling of double link failures. If both ports on a transit node are down and one port comes up, the node:

1. puts the port immediately into the forwarding state and starts forwarding data out that port. It does not need to wait, because the node knows there is no loop in the ring—because the other ring port on the node is down
2. remains in the Links Down state
3. starts a DoubleFailRecovery timer with a timeout of four seconds
4. waits for the timer to expire. At that time, if one port is still up and one is still down, the transit node sends a Ring-Up-Flush-FDB message out the port that is up. This message is usually called a "Fake Ring Up message".

Sending this message allows any ports on other transit nodes that are blocking or in the Pre-forwarding state to move to forwarding traffic in the Links Up state. The timer delay lets the device at the other end of the link that came up configure its port appropriately, so that it is ready to receive the transmitted message.

Note that the master node would not send a Ring-Up-Flush-FDB message in these circumstances, because the ring is not in a state of Complete. The master node's secondary port remains unblocked.

How To Configure EPSR

This section first outlines, step-by-step, how to configure EPSR. Then it discusses changing the settings for the control VLAN, if you need to do this after initial configuration.

Configuring EPSR

1. Connect your switches into a ring

EPSR does not in itself limit the number of nodes that can exist on any given ring. Each switch can participate in up to 16 rings.

If you already have a ring in a live network, disconnect the cable between any two of the nodes before you start configuring EPSR, to prevent a loop.

2. On each switch, configure EPSR

On each switch, perform the following configuration steps. Configuration of the master node and each transit node is very similar.

i. Configure the control VLAN

This step creates the control VLAN and adds the ring ports to it as tagged ports.

Enter the commands:

```
create vlan=control-vlan-name vid=control-vid
add vlan=control-vid port=ring-ports frame=tagged
```

Note that you can use trunk groups for the ring ports.

ii. Configure the data VLAN

This step creates the data VLAN (or VLANs—you can have as many as you want) and adds the ring ports as tagged ports.

Enter the commands:

```
create vlan=data-vlan-name vid=data-vid
add vlan=data-vid port=ring-ports frame=tagged
```

The two ring ports must belong to the control VLAN and all data VLANs.

iii. Remove the ring ports from the default VLAN

If you leave all the ring ports in the default VLAN (vlan1), they will create a loop, unless vlan1 is part of the EPSR domain. To avoid loops, you need to do one of the following:

- make vlan1 a data VLAN, or
- remove the ring ports from vlan1, or
- remove at least one of the ring ports from vlan1 on at least one of the switches. We do not recommend this option, because the action you have taken is less obvious when maintaining the network later.

In this How To Note, we remove the ring ports from the default VLAN. Use the command:

```
delete vlan=1 port=ring-ports
```

iv. Configure the EPSR domain

This step creates the domain, specifying whether the switch is the master node or a transit node. It also specifies which VLAN is the control VLAN, and on the master node which port is the primary port.

Enter one of the following commands:

On the master node:

```
create epsr=name mode=master controlvlan=control-vlan-name
  primaryport=port-number
```

On each transit node:

```
create epsr=name mode=transit controlvlan=control-vlan-name
```

This step also adds the data VLAN to the domain. Enter the command:

```
add epsr=name datavlan=data-vlan-name
```

v. Enable EPSR

This step enables the domain on each switch. Enter the command:

```
enable epsr=name
```

3. Configure other ports and protocols as required

On each switch, configure the other ports and protocols that are required for your network.

Modifying the Control VLAN

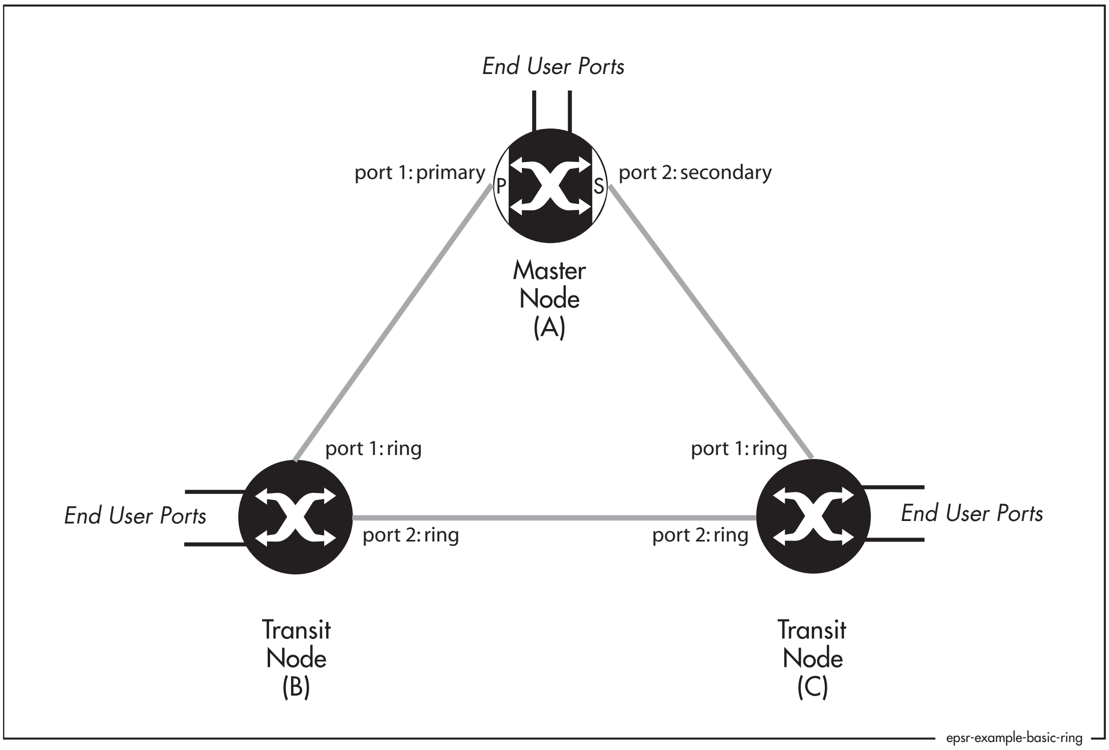
You cannot modify the control VLAN while EPSR is enabled. If you try to remove or add ports to the control VLAN, the switch generates an error message as follows:

```
Manager> delete vlan=1000 port=1
Error (3089409): VLAN 1000 is a control VLAN in EPSR and cannot be modified
```

Disable the EPSR domain and then make the required changes. Note that disabling EPSR will create a loop, so is not recommended on a network with live data. Of course, in a live network, you can manually prevent a loop by disconnecting the cable between any two of the nodes.

Example 1: A Basic Ring

This example builds a simple 3-switch ring with one data VLAN, as shown in the following diagram. Control packets are transmitted around the ring on vlan1000 and data packets on vlan2.



Configure the Master Node (A)

1. Create the control VLAN

```
create vlan=vlan1000 vid=1000
```

2. Add the ring ports to the control VLAN

```
add vlan=1000 port=1-2 frame=tagged
```

3. Create the data VLAN

```
create vlan=vlan2 vid=2
```

4. Add the ring ports to the data VLAN

The two ring ports must belong to the control VLAN and all data VLANs.

```
add vlan=2 port=1-2 frame=tagged
```

5. Remove the ring ports from the default VLAN

```
delete vlan=1 port=1-2
```

6. Create the EPSR domain

This step creates the domain, specifying that this switch is the master node. It also specifies which VLAN is the control VLAN and which port is the primary port.

```
create epsr=test mode=master controlvlan=vlan1000 primaryport=1
```

7. Add the data VLAN to the domain

```
add epsr=test datavlan=vlan2
```

8. Enable EPSR

```
enable epsr=test
```

Configure the Transit Nodes (B and C)

Each of the transit nodes has the same EPSR configuration in this example.

1. Create the control VLAN

```
create vlan=vlan1000 vid=1000
```

2. Add the ring ports to the control VLAN

```
add vlan=1000 port=1-2 frame=tagged
```

3. Create the data VLAN

```
create vlan=vlan2 vid=2
```

4. Add the ring ports to the data VLAN

The two ring ports must belong to both the control VLAN and all data VLANs.

```
add vlan=2 port=1-2 frame=tagged
```

5. Remove the ring ports from the default VLAN

```
delete vlan=1 port=1-2
```

6. Create the EPSR domain

This step creates the domain, specifying that this switch is the transit node. It also specifies which VLAN is the control VLAN.

```
create epsr=test mode=transit controlvlan=vlan1000
```

7. Add the data VLAN to the domain

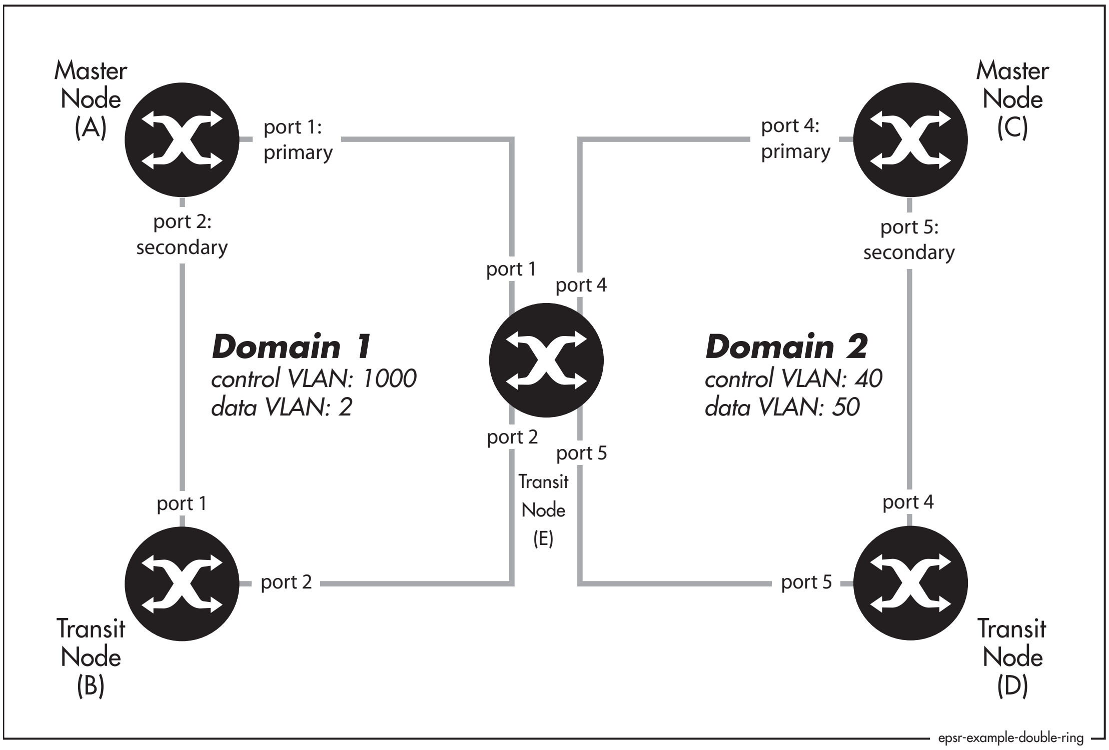
```
add epsr=test datavlan=vlan2
```

8. Enable EPSR

```
enable epsr=test
```

Example 2: A Double Ring

This example adds to the previous ring by making two domains, as shown in the following diagram.



1. Configure the master node (switch A) for domain 1

The master node for domain 1 is the same as in the previous example (except that the domain has been renamed).

```
create vlan=vlan1000 vid=1000
add vlan=1000 port=1-2 frame=tagged
create vlan=vlan2 vid=2
add vlan=2 port=1-2 frame=tagged
delete vlan=1 port=1-2
create epsr=domain1 mode=master controlvlan=vlan1000 primaryport=1
add epsr=domain1 datavlan=vlan2
enable epsr=domain1
```

2. Configure the transit node (switch B) that belongs just to domain 1

This transit node is the same as in the previous example (except that the domain has been renamed).

```
create vlan=vlan1000 vid=1000
add vlan=1000 port=1-2 frame=tagged
create vlan=vlan2 vid=2
add vlan=2 port=1-2 frame=tagged
delete vlan=1 port=1-2
create epsr=domain1 mode=transit controlvlan=vlan1000
add epsr=domain1 datavlan=vlan2
enable epsr=domain1
```

3. Configure the master node (switch C) for domain 2

Configure the control VLAN:

```
create vlan=vlan40 vid=40
add vlan=40 port=4-5 frame=tagged
```

Configure the data VLAN:

```
create vlan=vlan50 vid=50
add vlan=50 port=4-5 frame=tagged
```

Remove the ring ports from the default VLAN:

```
delete vlan=1 port=4-5
```

Configure EPSR:

```
create epsr=domain2 mode=master controlvlan=vlan40 primaryport=4
add epsr=domain2 datavlan=vlan50
enable epsr=domain2
```

4. Configure the transit node (switch D) that belongs just to domain 2

Configure the control VLAN:

```
create vlan=vlan40 vid=40
add vlan=40 port=4-5 frame=tagged
```

Configure the data VLAN:

```
create vlan=vlan50 vid=50
add vlan=50 port=4-5 frame=tagged
```

Remove the ring ports from the default VLAN:

```
delete vlan=1 port=4-5
```

Configure EPSR:

```
create epsr=domain2 mode=transit controlvlan=vlan40
add epsr=domain2 datavlan=vlan50
enable epsr=domain2
```

5. Configure the transit node (switch E) that belongs to both domains

Two separate EPSR domains are configured on this switch.

Configure the control VLAN for domain 1:

```
create vlan=vlan1000 vid=1000
add vlan=1000 port=1-2 frame=tagged
```

Configure the control VLAN for domain 2:

```
create vlan=vlan40 vid=40
add vlan=40 port=4-5 frame=tagged
```

Configure the data VLAN for domain 1:

```
create vlan=vlan2 vid=2
add vlan=2 port=1-2 frame=tagged
```

Configure the data VLAN for domain 2:

```
create vlan=vlan50 vid=50
add vlan=50 port=4-5 frame=tagged
```

Remove the ring ports from the default VLAN:

```
delete vlan=1 port=1-2,4-5
```

Configure EPSR for domain 1. This switch is a transit node:

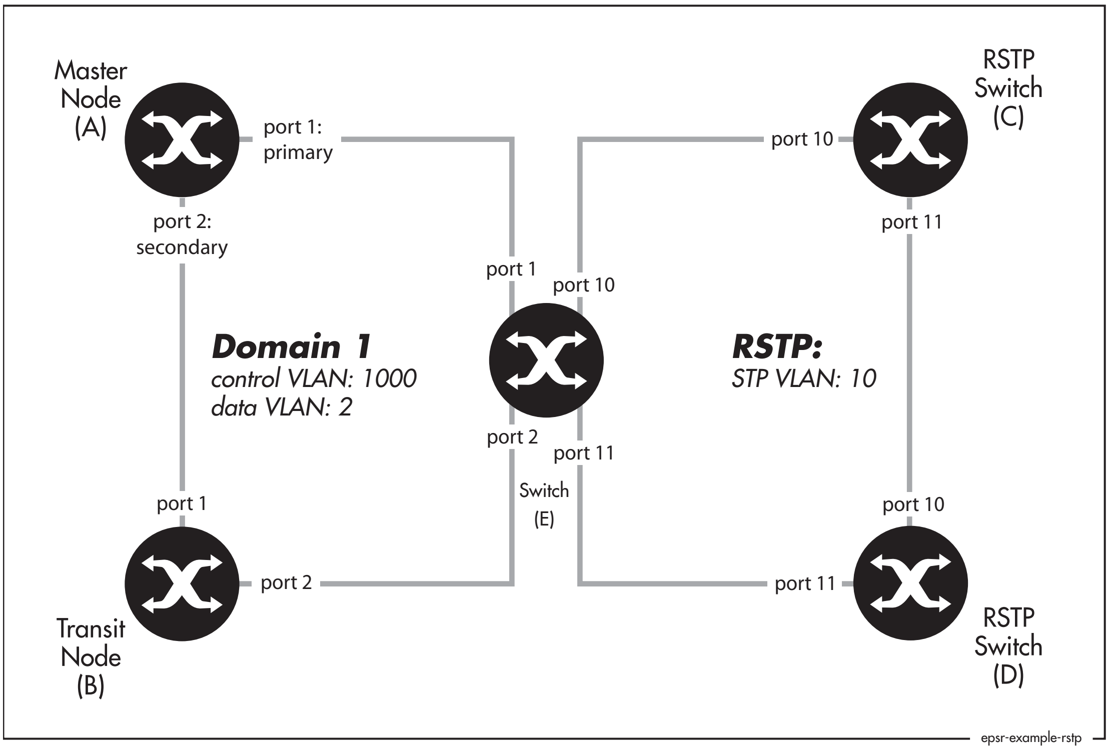
```
create epsr=domain1 mode=transit controlvlan=vlan1000
add epsr=domain1 datavlan=vlan2
enable epsr=domain1
```

Configure EPSR for domain 2. This switch is a transit node:

```
create epsr=domain2 mode=transit controlvlan=vlan40
add epsr=domain2 datavlan=vlan50
enable epsr=domain2
```

Example 3: EPSR and RSTP

This example uses EPSR to protect one ring and RSTP to protect another overlapping ring.



1. Configure the master node (switch A) for the EPSR domain

The master node is the same as in the previous example.

```
create vlan=vlan1000 vid=1000
add vlan=1000 port=1-2 frame=tagged
create vlan=vlan2 vid=2
add vlan=2 port=1-2 frame=tagged
delete vlan=1 port=1-2
create epsr=domain1 mode=master controlvlan=vlan1000 primaryport=1
add epsr=domain1 datavlan=vlan2
enable epsr=domain1
```

2. Configure the transit node (switch B) that belongs just to the EPSR domain

This transit node (B) is the same as in the previous example.

```
create vlan=vlan1000 vid=1000
add vlan=1000 port=1-2 frame=tagged
create vlan=vlan2 vid=2
add vlan=2 port=1-2 frame=tagged
delete vlan=1 port=1-2
create epsr=domain1 mode=transit controlvlan=vlan1000
add epsr=domain1 datavlan=vlan2
enable epsr=domain1
```

3. Configure the switches that belong to the RSTP instance (switches C and D)

Switches C and D have the same configuration in this example.

Configure the STP VLAN:

```
create vlan=vlan10 vid=10
add vlan=10 port=10-11 frame=tagged
```

Remove the STP VLAN's ports from the default VLAN:

```
delete vlan=1 port=10-11
```

Configure STP:

```
create stp=example
add stp=example vlan=vlan10
enable stp=example
set stp=example mode=rapid
```

4. Configure switch E for EPSR and RSTP

Configure the control VLAN for EPSR:

```
create vlan=vlan1000 vid=1000
add vlan=1000 port=1-2 frame=tagged
```

Configure the data VLAN for EPSR:

```
create vlan=vlan2 vid=2
add vlan=2 port=1-2 frame=tagged
```

Remove the ring ports from the default VLAN:

```
delete vlan=1 port=1-2
```

Configure EPSR:

```
create epsr=domain1 mode=transit controlvlan=vlan1000
add epsr=domain1 datavlan=vlan2
enable epsr=domain1
```

Configure the STP VLAN:

```
create vlan=vlan10 vid=10
add vlan=10 port=10-11 frame=tagged
```

Remove the STP VLAN’s ports from the default VLAN:

```
delete vlan=1 port=10-11
```

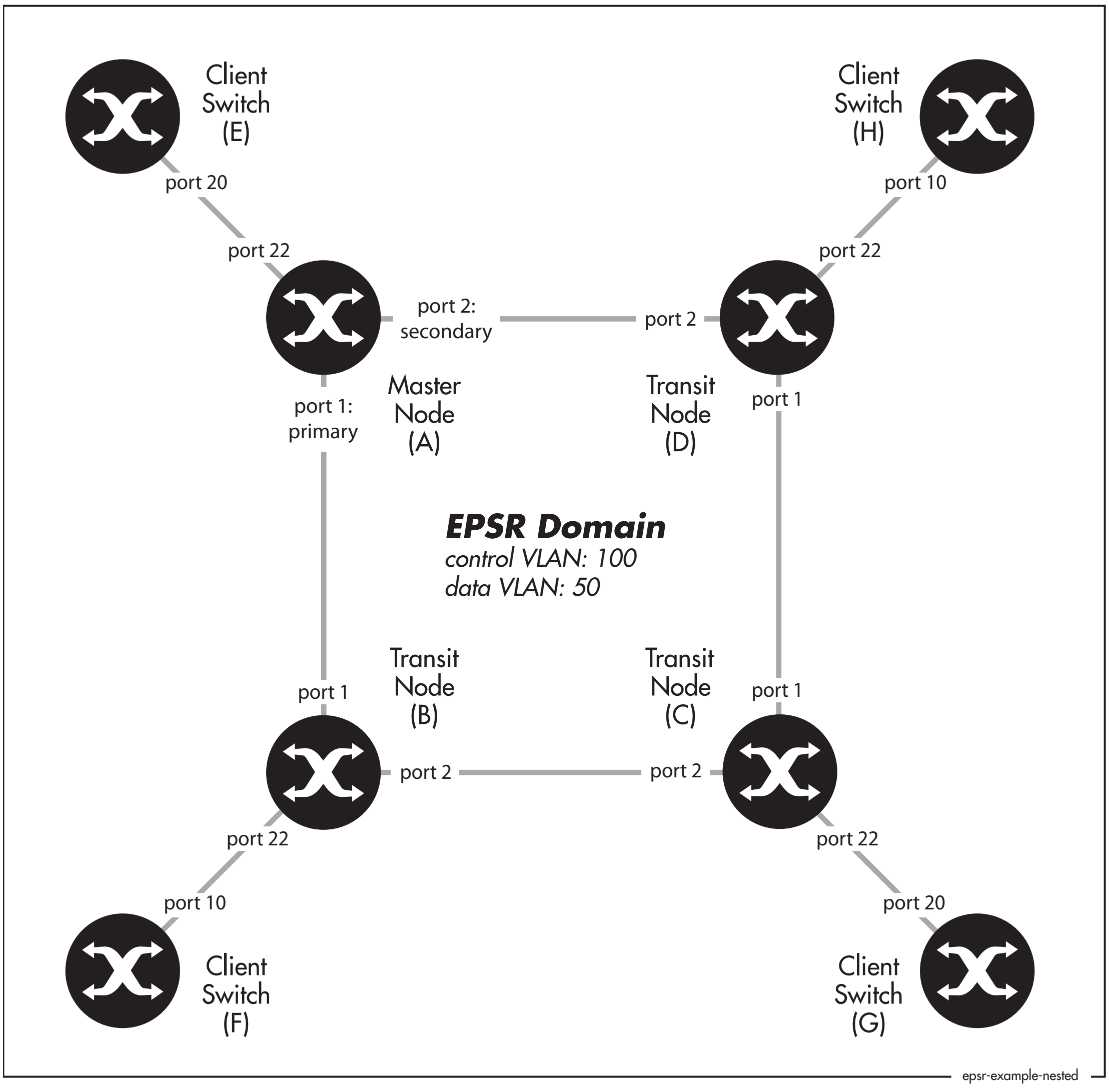
Configure STP:

```
create stp=example
add stp=example vlan=vlan10
enable stp=example
set stp=example mode=rapid
```

Example 4: EPSR with Nested VLANs

In this example:

- client switches A and C are in the same end-user VLAN (vlan20)
- client switches B and D are in the same end-user VLAN (vlan200)
- traffic for vlan20 and vlan200 is nested inside vlan50 for transmission around the core
- vlan50 is the data VLAN for the EPSR domain
- vlan100 is the control VLAN for the EPSR domain



1. Configure the master node (switch A) for the EPSR domain

Configure the EPSR control VLAN:

```
create vlan=vlan100 vid=100
add vlan=100 port=1-2 frame=tagged
```

Configure vlan50. This VLAN acts as both the nested VLAN and the EPSR data VLAN. The following commands create vlan50 and configure it as a nested VLAN:

```
create vlan=vlan50 vid=50 nested
add vlan=50 port=22 nestedtype=customer
add vlan=50 port=1-2 nestedtype=core
```

Remove the ring ports from the default VLAN:

```
delete vlan=1 port=1-2
```

Configure EPSR:

```
create epsr=example mode=master controlvlan=vlan100 primaryport=1
add epsr=example datavlan=vlan50
enable epsr=example
```

2. Configure the transit nodes (switches B, C and D) for the EPSR domain

Each of the transit nodes has the same EPSR configuration in this example.

Configure the EPSR control VLAN:

```
create vlan=vlan100 vid=100
add vlan=100 port=1-2 frame=tagged
```

Configure vlan50, which acts as both the nested VLAN and the EPSR data VLAN:

```
create vlan=vlan50 vid=50 nested
add vlan=50 port=22 nestedtype=customer
add vlan=50 port=1-2 nestedtype=core
```

Remove the ring ports from the default VLAN:

```
delete vlan=1 port=1-2
```

Configure EPSR:

```
create epsr=example mode=transit controlvlan=vlan100
add epsr=example datavlan=vlan50
enable epsr=example
```

3. Configure client switch E (connected to the master node)

```
create vlan=vlan20 vid=20
add vlan=20 port=20 frame=tagged
enable ip
add ip interface=vlan20 ip=192.168.20.10
```

4. Configure client switch F (connected to transit node B)

```
create vlan=vlan200 vid=200
add vlan=200 port=10 frame=tagged
enable ip
add ip interface=vlan200 ip=192.168.200.1
```

5. Configure client switch G (connected to transit node C)

```
create vlan=vlan20 vid=20
add vlan=20 port=20 frame=tagged
enable ip
add ip int=vlan20 ip=192.168.20.1
```

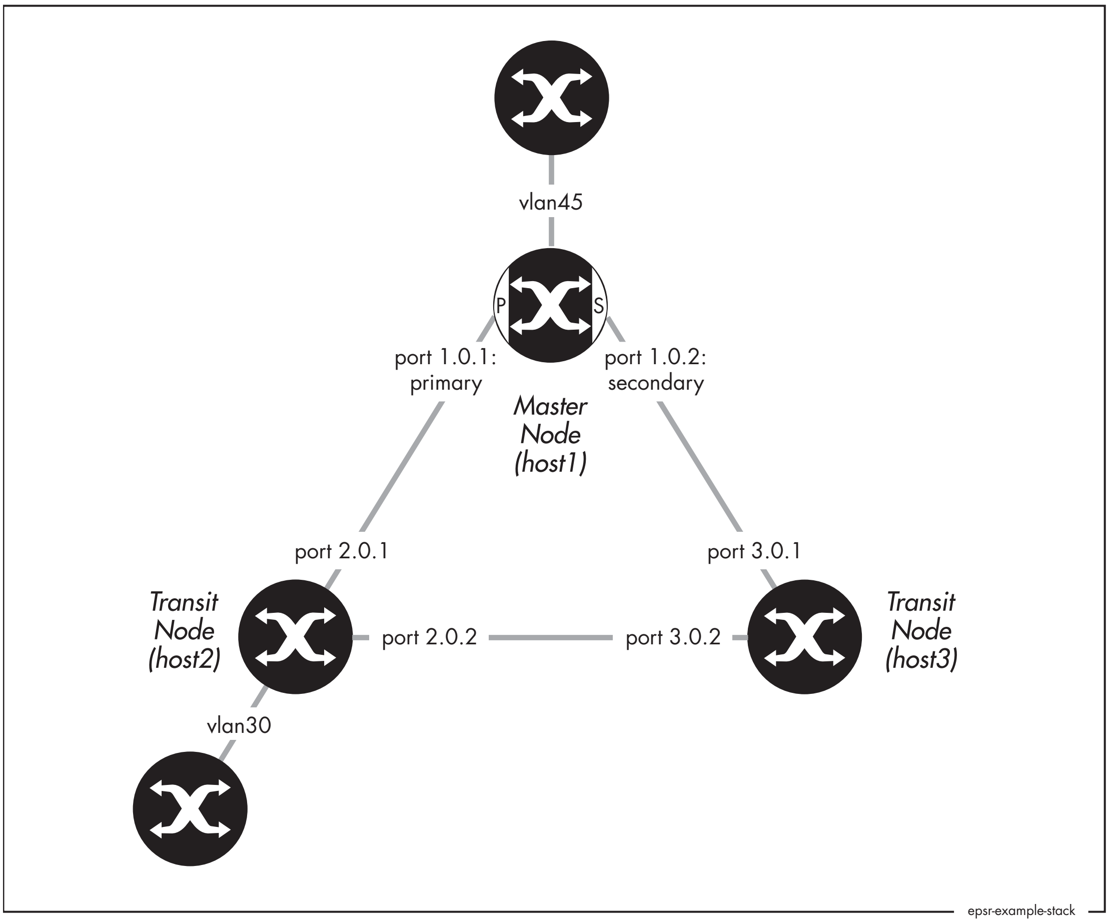
6. Configure client switch H (connected to transit node D)

```
create vlan=vlan200 vid=200
add vlan=200 port=10 frame=tagged
enable ip
add ip interface=vlan200 ip=192.168.200.10
```

Example 5: EPSR with management stacking

In this example:

- three switches are stacked together, so you can manage all three switches by entering commands into the CLI of any one of them
- the three switches are also configured as an EPSR domain
- vlan1000 is used as the stacking VLAN and as the EPSR control VLAN. Stacked switches use the stacking VLAN to communicate with each other
- the data VLAN for EPSR is vlan20
- ports on the stacked switches are numbered using the stacking scheme of *hostid.0.port*



1. Configure stacking on the master node for the EPSR domain (host1)

The following commands must be entered into the CLI of this particular switch.

First, give the switch a host ID number so that the stack can identify it:

```
set system hostid=1 serialnumber=12345678
set system name=host1
```

Create the stacking VLAN and add the ring ports to it. Note the port numbering notation—these are ports 1 and 2 on stacking host 1. Because this VLAN will also be the EPSR control VLAN, this step also adds the ring ports to the control VLAN. Use the commands:

```
create vlan=stack vid=1000
add vlan=1000 port=1.0.1-1.0.2 frame=tagged
delete vlan=1 port=1.0.1-1.0.2
```

Add the stacking VLAN to the stack and enable stacking:

```
add stack interface=vlan1000
enable stack
```

2. Configure stacking on the first transit node (host2)

These commands must be entered into the CLI of this particular switch.

```
set system hostid=2 serialnumber=23456789
set system name=host2
create vlan=stack vid=1000
add vlan=1000 port=2.0.1-2.0.2 frame=tagged
delete vlan=1 port=2.0.1-2.0.2
add stack interface=vlan1000
enable stack
```

3. Configure stacking on the second transit node (host3)

These commands must be entered into the CLI of this particular switch.

```
set system hostid=3 serialnumber=34567890
set system name=host3
create vlan=stack vid=1000
add vlan=1000 port=3.0.1-3.0.2 frame=tagged
delete vlan=1 port=3.0.1-3.0.2
add stack interface=vlan1000
enable stack
```

4. Configure the other VLANs on the stacked switches

The stack now exists, so you can configure all three switches from the CLI of the master node (or any other of the switches). However, the ports and IP addresses are different for each switch, so you need to make most of the commands host-directed.

Create the EPSR data VLAN. This command will propagate to all three switches:

```
create vlan=vlan20 vid=20
```

Assign ports and an IP address to the data VLAN on each switch. You can type the following commands into any switch in the stack. To apply them to the correct switches, make them host-directed by starting each command with the host ID number of the target switch. Therefore, use the following commands:

```
1: add vlan=20 port=1.0.1-1.0.2 frame=tagged
1: add ip int=vlan20 ip=192.168.20.1
2: add vlan=20 port=2.0.1-2.0.2 frame=tagged
2: add ip int=vlan20 ip=192.168.20.2
3: add vlan=20 port=3.0.1-3.0.2 frame=tagged
3: add ip int=vlan20 ip=192.168.20.3
```

Configure other VLANs as required. In this example, two of the switches have other VLANs attached:

```
1: create vlan=vlan45 vid=45
1: add vlan=45 port=1.0.23-1.0.24 frame=tagged
1: add ip int=vlan45 ip=192.168.45.1
2: create vlan=vlan30 vid=30
2: add vlan=30 port=2.0.10 frame=tagged
2: add ip int=vlan30 ip=192.168.30.1
```

Enable IP on the whole stack:

```
enable ip
```

5. Configure EPSR on the stacked switches

Create the EPSR domain:

```
1: create epsr=example mode=master controlvlan=stack primary=1.0.1
2: create epsr=example mode=transit controlvlan=stack
3: create epsr=example mode=transit controlvlan=stack
```

Specify the data VLAN:

```
add epsr=example datavlan=vlan20
```

Enable the EPSR domain:

```
enable epsr=example
```

Example 6: EPSR with an iMAP

This example is the same as "Example 1: A Basic Ring" on page 11 except that one of the three switches is an iMAP. We used an AT-TN7100 iMAP running 6.1.10. The ring ports on the iMAP are 5.0 and 5.1. The example first shows the configuration script for the iMAP as the master node, then as the transit node. For the configuration of the other two switches, see Example 1.

Configure the AT-TN7100 iMAP as Master Node

The following diagram shows a partial script for the iMAP, with the commands for configuring it as a EPSR master node and other relevant commands.

```
ADD IP INTERFACE=MGMT IPADDRESS=172.28.9.3 SUBNETMASK=255.255.255.0
CARD=ACTCFC GATEWAY=172.28.9.1
#
SET SWITCH AGEINGTIMER=300
#
SET SYSTEM PROVMODE=AUTO
SET SYSTEM GATEWAY=172.28.9.1
#
CREATE EPSR=test MASTER HELLOTIME=1 FAILOVERTIME=2 RINGFLAPTIME=0
#
CREATE VLAN=vlan2 VID=2 FORWARDINGMODE=STD
CREATE VLAN=vlan1000 VID=1000 FORWARDINGMODE=STD
#
ADD VLAN=2 INTERFACE=ETH:[5.0-1] FRAME=TAGGED
ADD VLAN=1000 INTERFACE=ETH:[5.0-1] FRAME=TAGGED
#
DELETE VLAN=1 INTERFACE=ETH:[5.0-1]
#
SET INTERFACE=ETH:[5.0-1] ACCEPTABLE=VLAN
#
ADD EPSR=test INTERFACE=ETH:[5.0] TYPE=PRIMARY
ADD EPSR=test INTERFACE=ETH:[5.1] TYPE=SECONDARY
ADD EPSR=test VLAN=1000 TYPE=CONTROL
ADD EPSR=test VLAN=2 TYPE=DATA
#
ENABLE EPSR=test
```

Checking the Master Node Configuration

To see a summary, use the command:

```
show epsr
```

The following diagram shows the expected output.

```
--- EPSR Domain Information ---------------------------------------------------

   EPSR Domain   Node Type Domain Status/  Control Interface(s) (PhysicalState,
                                State        Vlan           Type, State)
 --------------- --------- --------------- ------- ----------------------------
 test             MASTER     EN/COMPLETE    1000   5.0 (UP,DNSTRM,FWDING ),
                                                   5.1 (UP,DNSTRM,BLOCKED)

-------------------------------------------------------------------------------
```

To see details, use the command:

```
show epsr=test
```

The following diagram shows the expected output.

```
--- EPSR Domain Information ---------------------------------------------------

 EPSR Domain Name...................... test
 EPSR Domain Node Type................. Master
 EPSR Domain State..................... COMPLETE
 MAC Address of Master Node............ 00:00:CD:28:06:19
 EPSR Domain Status.................... Enabled
 Control Vlan.......................... 1000
 Primary Interface..................... 5.0
 Physical State of Primary Interface... UP
 Primary Interface Type................ DOWNSTREAM
 Primary Interface State............... FORWARDING
 Secondary Interface................... 5.1
 Physical State of Secondary Interface. UP
 Secondary Interface Type.............. DOWNSTREAM
 Secondary Interface State............. BLOCKED
 Hello Timer (seconds.................. 1
 Failover Timer (seconds).............. 2
 RingFlap Timer (seconds).............. 0
 Hello Time Remaining (seconds)........ 1
 Failover Time Remaining (seconds)..... 0
 RingFlap Time Remaining (seconds)..... 0
 Hello Sequence........................ 526
 Data Vlans............................ 2

-------------------------------------------------------------------------------
```

Configure the AT-TN7100 iMAP as a Transit Node

The following diagram shows a partial script for the iMAP, with the commands for configuring it as a transit node.

```
CREATE EPSR=test TRANSIT
#
CREATE VLAN=vlan2 VID=2 FORWARDINGMODE=STD
CREATE VLAN=vlan1000 VID=1000 FORWARDINGMODE=STD
#
DISABLE INTERFACE=0.0-0.15,1.0-1.15,2.0-2.15,4.0-4.1,5.0-5.1
#
ADD VLAN=2 INTERFACE=ETH:[5.0-1] FRAME=TAGGED
ADD VLAN=1000 INTERFACE=ETH:[5.0-1] FRAME=TAGGED
#
DELETE VLAN=1 INTERFACE=ETH:[5.0-1]
#
SET INTERFACE=0.0-0.15,1.0-1.15,2.0-2.15,4.0-4.1,5.0-5.1
    PROFILE=AutoProv
SET INTERFACE=ETH:[5.0-1] ACCEPTABLE=VLAN
#
ADD EPSR=test INTERFACE=ETH:[5.0-1]
ADD EPSR=test VLAN=1000 TYPE=CONTROL
ADD EPSR=test VLAN=2 TYPE=DATA
#
ENABLE EPSR=test
#
ENABLE INTERFACE=0.0-0.15,1.0-1.15,2.0-2.15,4.0-4.1,5.0-5.1
```

Checking the Transit Node Configuration

To see a summary, use the command:

```
show epsr
```

The following diagram shows the expected output.

```
--- EPSR Domain Information ---------------------------------------------------

   EPSR Domain   Node Type Domain Status/  Control Interface(s) (PhysicalState,
                                State        Vlan          Type, State)
 --------------- --------- --------------- ------- ----------------------------
 test             TRANSIT    EN/LINKS-UP    1000   5.0 (UP,UPSTRM,FWDING ),
                                                   5.1 (UP,DNSTRM,FWDING )

-------------------------------------------------------------------------------
```

To see details, use the command:

```
show epsr=test
```

The following diagram shows the expected output.

```
--- EPSR Domain Information ----------------------------------------------------

 EPSR Domain Name...................... test
 EPSR Domain Node Type................. Transit
 EPSR Domain State..................... LINKS-UP
 MAC Address of Master Node............ 00:00:CD:24:02:4F
 EPSR Domain Status.................... Enabled
 Control Vlan.......................... 1000
 Ring Interface # 1.................... 5.0
 Physical State of Ring Interface # 1.. UP
 Ring Interface # 1 Type............... UPSTREAM
 Ring Interface # 1 State.............. FORWARDING
 Ring Interface # 2.................... 5.1
 Physical State of Ring Interface # 2.. UP
 Ring Interface # 2 Type............... DOWNSTREAM
 Ring Interface # 2 State.............. FORWARDING
 Hello Timer (seconds.................. N/A
 Failover Timer (seconds).............. N/A
 Ringflap Timer (seconds).............. N/A
 Hello Time Remaining (seconds)........ N/A
 Failover Time Remaining (seconds)..... N/A
 Ringflap Time Remaining (seconds)..... N/A
 Hello Sequence........................ N/A
 Data Vlans............................ 2

--------------------------------------------------------------------------------
```

Classifiers and Hardware Filters

On AT-8948, AT-9900, AT-9900s, and x900 series switches, the switching hardware has a limit of 16 bytes to use for matching on incoming packets.

EPSR creates a hardware filter that uses 2 bytes for VLAN identification (since version 291-04). This means that you have to design your network carefully when using EPSR with DHCP snooping, QoS, or other hardware filters.

For example:

- DHCP snooping uses 5 bytes to match on the source and destination UDP ports and the protocol field. With EPSR and DHCP snooping both enabled, 7 out of the 16 bytes are used.
- IP addresses use 4 bytes. So if you configured EPSR, DHCP snooping, and a QoS policy that classified on source IP address, then 11 of the 16 bytes would be used.

Ports and Recovery Times

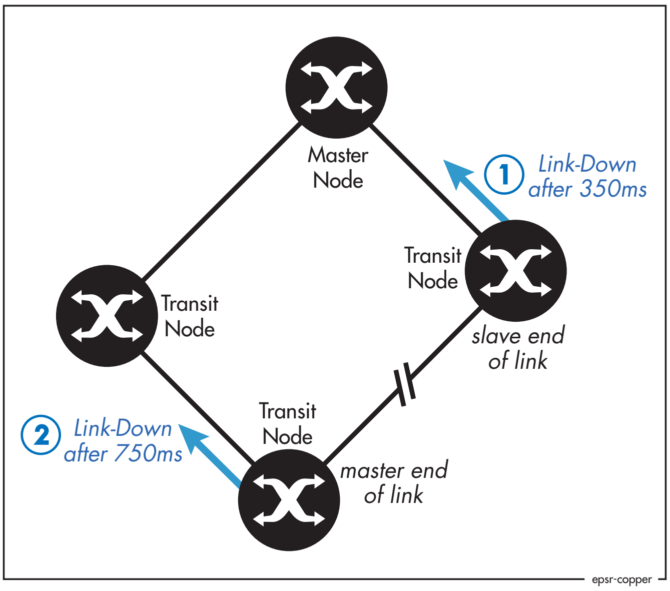
In practice, recovery time in an EPSR ring is generally between 50 and 100ms. However, it depends on the port type, because this determines how long it takes for the port to report that it is down and send a Link-Down message.

The following ports report that they are down immediately or within a few milliseconds, which leads to an EPSR recovery time of 50 to 100ms:

- 10/100M copper RJ-45 ports
- tri-speed copper RJ-45 ports operating at 10 or 100M
- fiber 1000M ports
- 10G ports

However, for tri-speed copper RJ-45 ports operating at 1000M, there is a short delay—either 350ms or 750ms—before the port reports that it is down. This is because the IEEE standard for 1000BASE-T specifies that a port must wait for a certain length of time after a link goes down before it decides that the link is actually down (see Section 40.4.5.2 of IEEE Std 802.3-2002). The length of the wait depends on whether the 1000BASE-T port is “master” or “slave” end of the link (“master” and “slave” are determined when the port autonegotiates and are not related to the master node of EPSR). If a 1000BASE-T port is the master the wait is 750ms; if it is the slave, the wait is 350ms.

This means that if a 1000M copper link goes down between two transit nodes, EPSR recovers after approximately 350ms. The EPSR nodes at both ends of the broken link send a Link-Down message when they detect that the link has gone down. As the diagram shows, the node at the slave end of the link sends a Link-Down message in 350ms. The node at the master end does not send a Link-Down message until 750ms have passed, but by then the EPSR master node has already handled the first Link-Down message. You can see the messages in the debugging output in "Link Down Between Two Transit Nodes" on page 47.



For almost all networks, this slight delay in recovery has no practical effect. For networks with extremely stringent failover requirements, we recommend using fiber 1000M ports instead of copper.

IGMP Snooping and Recovery Times

Since Software Version 281-03, IGMP snooping includes **query solicitation**, a new feature that minimises loss of multicast data after a topology change.

When IGMP snooping is enabled on a VLAN, and EPSR changes the underlying link layer topology of that VLAN, this can interrupt multicast data flow for a significant length of time. Query solicitation prevents this by monitoring the VLAN for any topology changes. When it detects a change, it generates a special IGMP Leave message known as a Query Solicit, and floods the Query Solicit message to all ports. When the IGMP Querier receives the message, it responds by sending a General Query. This refreshes snooped group membership information in the network.

Query solicitation functions by default (without you enabling it) on the EPSR master node. By default, the master node always sends a Query Solicit message when the topology changes.

On other switches in the network, the query solicitation is disabled by default, but you can enable it by using the command:

```
set igmpsnooping vlan={vlan-name|1..4094|all}
   querysolicit={on|yes|true}
```

If you enable query solicitation on an EPSR transit node, both that node and the master node send a Query Solicit message.

Once the Querier receives the Query Solicit message, it sends out a General Query and waits for responses, which update the snooping information throughout the network. If necessary, you can reduce the time this takes by tuning the IGMP timers, especially the **queryresponseinterval** parameter. For more information, see the “IGMP Timers and Counters” section of “How To Configure IGMP on Allied Telesyn Routers and Switches for Multicasting”. This How To Note is available in the Resource Center of the Documentation and Tools CDROM for Software Version 2.8.1, or from:
www.alliedtelesyn.co.uk/en-gb/solutions/techdocs.asp?area=howto

Query solicitation also works with networks that use Spanning Tree (STP, RSTP, or MSTP).

Health Message Priority

EPSR uses Health messages to check that the ring is intact. If switches in the ring were to drop Health messages, this could make the ring unstable. Therefore, Health messages are sent to the highest priority queue (queue 7), which uses strict priority scheduling by default. This makes sure that the switches forward Health messages even if the network is congested.

We recommend that you leave queue 7 as the highest priority queue, leave it using strict priority scheduling, and only send essential control traffic to it.

In the unlikely event that this is impossible, you can increase the failover time so that the master node only changes the ring topology if several Health messages in a row fail to arrive. By default, the failover time is set to two seconds, which means that the master node decides that the ring is down if two Health messages in a row fail to arrive.

EPSR State and Settings

To display the EPSR state, the attached VLANs, the ring ports, and the timer values, use the command:

```
show epsr
```

Master Node in a Complete Ring

The following diagram shows the output for a master node in a ring that is in a state of Complete. As well as giving the state as Complete, it also shows that port 1 is the primary port and port 2 is the secondary port. Note that the secondary port is blocked, so does not forward packets over the data VLAN (vlan2).

```
 EPSR Information
-------------------------------------------------------------------------
 Name ........................ test
 Mode .......................... Master
 Status ........................ Enabled
 State ......................... Complete
 Control Vlan .................. vlan1000 (1000)
 Data VLAN(s) .................. vlan2 (2)
 Primary Port .................. 1
 Primary Port Status ........... Forwarding
 Secondary Port ................ 2
 Secondary Port Status ......... Blocked
 Hello Time .................... 1 s
 Failover Time ................. 2 s
 Ring Flap Time ................ 0 s
 Trap .......................... Enabled
-------------------------------------------------------------------------
```

Transit Node in a Complete Ring

The following diagram shows the output for a transit node in a ring that is in a state of Complete. Note that the State is Links-Up, not Complete. Only the master node shows Complete as the state.

```
 EPSR Information
-------------------------------------------------------------------------
 Name ........................ test
 Mode .......................... Transit
 Status ........................ Enabled
 State ......................... Links-Up
 Control Vlan .................. vlan1000 (1000)
 Data VLAN(s) .................. vlan2 (2)
 First Port .................... 1
 First Port Status ............. Forwarding
 First Port Direction .......... Upstream
 Second Port ................... 2
 Second Port Status ............ Forwarding
 Second Port Direction ......... Downstream
 Trap .......................... Enabled
 Master Node ................... 00-00-cd-28-06-19
-------------------------------------------------------------------------
```

Master Node in a Failed Ring

In contrast, the following diagram shows the output for a master node in a ring that is in a Failed state. Both ring ports are now forwarding.

```
 EPSR Information
------------------------------------------------------------------------
 Name ........................ domain1
 Mode .......................... Master
 Status ........................ Enabled
 State ......................... Failed
 Control Vlan .................. vlan1000 (1000)
 Data VLAN(s) .................. vlan2 (2)
 Primary Port .................. 1
 Primary Port Status ........... Forwarding
 Secondary Port ................ 2
 Secondary Port Status ......... Forwarding
 Hello Time .................... 1 s
 Failover Time ................. 2 s
 Ring Flap Time ................ 0 s
 Trap .......................... Enabled
------------------------------------------------------------------------
```

SNMP Traps

You can use SNMP traps to notify you when events occur in the EPSR ring.

Download the latest version of the Allied Telesis Enterprise MIB from www.alliedtelesis.co.nz/support/updates/patches.html. The EPSR Group is contained in the sub-file called atr-epsr.mib.

The EPSR Group has the object identifier prefix epsr ({ modules 136}), and contains a collection of objects and traps for monitoring EPSR states.

The following trap is defined under the epsrEvents ({ epsr 0}) subtree:

- atrEpsrNodeTrap ({ epsrEvents 1}) is the trap type of the EPSR node trap (master/transit).

The following objects are defined under the epsrEventVariables ({ epsr 1}) subtree:

- atrEpsrNodeTrapType ({epsrEventVariables 1}) is the trap type of the EPSR node trap (master/transit).
- atrEpsrDomainName ({epsrEventVariables 2}) is the name assigned to the EPSR domain.
- atrEpsrFromState ({epsrEventVariables 3}) is the defined state that an EPSR domain is transitioning from.
- atrEpsrToState ({epsrEventVariables 4}) is the state that an EPSR domain is transitioning to.
- atrEpsrControlVLANId ({epsrEventVariables 5}) is the VLAN identifier for the control VLAN.
- atrEpsrPrimaryIfIndex ({epsrEventVariables 6}) is the ifIndex of the primary interface.
- atrEpsrPrimaryIfState ({epsrEventVariables 7}) is the current state of the primary interface.
- atrEpsrSecondaryIfIndex ({epsrEventVariables 8}) is the ifIndex of the secondary interface.
- atrEpsrSecondaryIfState ({epsrEventVariables 9}) is the current state of the secondary interface.

Counters

The EPSR counters record the number of EPSR messages that the CPU received and transmitted. To display the counters, use the command:

```
show epsr=domain1 count
```

Master node in a Complete ring

The following diagram shows the counters for a master node in a ring that has never had a link or node fail.

```
 EPSR Counters
------------------------------------------------------------------------
 Name: domain1
  Receive:                                Transmit:
  Total EPSR Packets           1093       Total EPSR Packets        1093
  Health                       1092       Health                    1092
  Ring Up                      1          Ring Up                   1
  Ring Down                    0          Ring Down                 0
  Link Down                    0          Link Down                 0
  Invalid EPSR Packets         0
------------------------------------------------------------------------
```

Note that the node has generated 1093 EPSR packets (and sent them out its primary port) and has received the same number of EPSR packets (on its secondary port).

However, it is very common to see a few Link Down, Ring Down, and Ring Up entries in the output of a ring that has never been in a Failed state. These messages are produced when you first enable EPSR, if some ring nodes establish before others.

Transit Node in a ring that had failures

In contrast, the following diagram shows the counters for a transit node in a ring that has been in a Failed state twice.

```
 EPSR Counters
------------------------------------------------------------------------
 Name: domain1
  Receive:                                Transmit:
  Total EPSR Packets           1425       Total EPSR Packets        2
  Health                       1423       Health                    0
  Ring Up                      2          Ring Up                   0
  Ring Down                    0          Ring Down                 0
  Link Down                    0          Link Down                 2
  Invalid EPSR Packets         0
------------------------------------------------------------------------
```

Here, the transit node has received 1421 Health messages, which it will have forwarded on if its ports were up. These messages do not show in the transmit counters because they are transmitted by the switching hardware, not the CPU.

The node has also generated two Link-Down messages, indicating that on two separate occasions one of its links has gone down.

Debugging

This section walks you through the EPSR debugging output as links go down and come back up again. The debugging output comes from the ring in "Example 1: A Basic Ring" on page 11. The output shows what happened when we took down two separate links in turn:

- first, the link between the master node's primary port and transit node B
- second, the link between the two transit nodes B and C

To enable debugging on the domain called "test", use the command:

```
enable epsr=test debug=all
```

Note that the master node transmits Health messages every second by default. The debugging displays every message, including all Health messages. Therefore, we recommend that you capture the debugging output for separate analysis, to make analysis simpler.

Link Down Between Master Node and Transit Node

This section shows the debugging output when the link between the master node's primary port and transit node B goes down and comes back up again. It shows the debugging output for the complete failure and recovery cycle:

- first on the master node
- then on transit node B.

Master Node (Node A) Debug Output

The following debugging output starts with the ring established and in a state of Complete.

1. The master node sends Health messages

Each time the Hello timer expires, the master node sends a Health message out its primary port (port 1). As long as the ring is in a state of Complete, it receives each Health message again on its secondary port (port 2). Note that in the System field, this output shows the MAC address of the source of the message—the master node in this case.

```
Manager x900-48-A>
epsrHelloTimeout: EPSR test Hello Timer expired
EPSR Port1 Tx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
    00bb0100 00541f2a 00000000 0000cd28 0619990b 00400105 03e80000
    00000000 cd280619 00010002 010000be

 EPSR Port1 Tx:
 -----------------------------------------------------------------------
          TYPE = HEALTH                          STATE = COMPLETE
     CTRL VLAN = 1000                           SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                           FAIL TIME = 2
     HELLO SEQ = 190
 -----------------------------------------------------------------------
EPSR Port2 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
    00bb0100 00541f2a 00000000 0000cd28 0619990b 00400105 03e80000
    00000000 cd280619 00010002 010000be

 EPSR Port2 Rx:
 -----------------------------------------------------------------------
          TYPE = HEALTH                          STATE = COMPLETE
     CTRL VLAN = 1000                           SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                           FAIL TIME = 2
     HELLO SEQ = 190
 -----------------------------------------------------------------------
```

2. The master node continues sending Health messages

The master node continues sending Health messages, and increments the Hello Sequence number with each message. If all nodes and links in the ring are intact, these Health messages are the only debugging output you see.

```
 .
 .
 .
Manager x900-48-A>
epsrHelloTimeout: EPSR test Hello Timer expired
EPSR Port1 Tx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
    00bb0100 00541eef 00000000 0000cd28 0619990b 00400105 03e80000
    00000000 cd280619 00010002 010000f9

 EPSR Port1 Tx:
 -----------------------------------------------------------------------
          TYPE = HEALTH                    STATE = COMPLETE
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                     FAIL TIME = 2
     HELLO SEQ = 249
 -----------------------------------------------------------------------
EPSR Port2 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
    00bb0100 00541eef 00000000 0000cd28 0619990b 00400105 03e80000
    00000000 cd280619 00010002 010000f9

 EPSR Port2 Rx:
 -----------------------------------------------------------------------
          TYPE = HEALTH                    STATE = COMPLETE
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                     FAIL TIME = 2
     HELLO SEQ = 249
 -----------------------------------------------------------------------
```

3. The primary port goes down

The link between the master node's primary port and the neighbouring transit node goes down. Therefore, the master node detects that its primary port (port 1) has gone down.

```
EPSR test, Port 1 port down
Flush FDB EPSR: test  vid: 2
```

4. The master node receives a Link-Down message on its secondary port

The master node receives a Link-Down message on its secondary port (port 2) from transit node B, which is at the other end of the broken link.

```
EPSR Port2 Rx:  00e02b00 00040000 cd24024f 8100e3e8 005caaaa 0300e02b
    00bb0100 00542484 00000000 0000cd24 024f990b 00400108 03e80000
    00000000 cd24024f 00000000 04000000

 EPSR Port2 Rx:
 -----------------------------------------------------------------------
          TYPE = LINK-DOWN                 STATE = LINK-DOWN
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-24-02-4f
    HELLO TIME = 0                     FAIL TIME = 0
     HELLO SEQ = 0
 -----------------------------------------------------------------------
```

In the System field, this output shows the MAC address of the source of the message—the transit node in this case.

5. The master node transmits a Ring-Down-Flush-FDB message

The master switch responds to the break in the ring by sending a Ring-Down-Flush-FDB message, which tells each transit node to learn the new topology. The master node also unblocks its secondary port for the data VLAN (vlan2), flushes its FDB, sends an SNMP trap, and changes the EPSR state to Failed. Note that the master node sends the Ring-Down-Flush-FDB message only out its secondary port, because the link between the primary port and the neighbouring transit node is down.

```
EPSR Port2 Tx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
    00bb0100 00541ee9 00000000 0000cd28 0619990b 00400107 03e80000
    00000000 cd280619 00000000 02000000

 EPSR Port2 Tx:
 -----------------------------------------------------------------------
          TYPE = RING-DOWN-FLUSH-FDB       STATE = FAILED
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 0                     FAIL TIME = 0
     HELLO SEQ = 0
 -----------------------------------------------------------------------
Unblock EPSR:test port:2 VLAN:2
Flush FDB EPSR: test  vid: 2
EPSR INFO: Send trap EPSR:test oldState:COMPLETE newState:FAILED
    nodeType:MASTER
EPSR test oldState:COMPLETE newState:FAILED
```

6. The Hello timer expires

The Hello timer expires, which would normally trigger the master node to send a Health message out the primary port. However, the link between the primary port and the neighbouring transit node is down, so the master node does not send the Health message.

```
Manager x900-48-A>
epsrHelloTimeout: EPSR test Hello Timer expired
Manager x900-48-A>
epsrHelloTimeout: EPSR test Hello Timer expired
Manager x900-48-A>
epsrHelloTimeout: EPSR test Hello Timer expired
Manager x900-48-A>
epsrHelloTimeout: EPSR test Hello Timer expired
```

7. The primary port comes back up

The primary port comes back up. The master node immediately blocks that port for vlan2 to prevent a loop.

```
Manager x900-48-A>
EPSR test, Port 1 port up
Block EPSR:test port:1 VLAN:2
```

8. The Hello timer expires again

The Hello timer expires again. Port 1 is now up, so this time the master node sends a Health message. The Health message shows that the EPSR state is Failed.

Note that the hello sequence number increments from the number it was before the primary port went down, because the master node could not transmit Health messages while the port was down.

```
Manager x900-48-A>
epsrHelloTimeout: EPSR test Hello Timer expired
EPSR Port1 Tx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
    00bb0100 00541dee 00000000 0000cd28 0619990b 00400105 03e80000
    00000000 cd280619 00010002 020000fa

 EPSR Port1 Tx:
 -----------------------------------------------------------------------
          TYPE = HEALTH                    STATE = FAILED
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                     FAIL TIME = 2
     HELLO SEQ = 250
 -----------------------------------------------------------------------
```

9. The master node receives the Health message on its secondary port

The master node receives the Health message on its secondary port (port 2). This tells it that all links on the ring are up again.

```
EPSR Port2 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
    00bb0100 00541dee 00000000 0000cd28 0619990b 00400105 03e80000
    00000000 cd280619 00010002 020000fa

 EPSR Port2 Rx:
 -----------------------------------------------------------------------
          TYPE = HEALTH                          STATE = FAILED
     CTRL VLAN = 1000                           SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                           FAIL TIME = 2
     HELLO SEQ = 250
 ----------------------------------------------------------------------
```

10. The master node returns the ring to a state of Complete

The master node blocks its secondary port for the data VLAN, unblocks its primary port, transmits a Ring-Up-Flush-FDB message, flushes its FDB, sends a trap, and changes the EPSR state to Complete.

```
Block EPSR:test port:2 VLAN:2
Unblock EPSR:test port:1 VLAN:2
EPSR Port1 Tx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
    00bb0100 00541fea 00000000 0000cd28 0619990b 00400106 03e80000
    00000000 cd280619 00000000 01000000

 EPSR Port1 Tx:
 -----------------------------------------------------------------------
          TYPE = RING-UP-FLUSH-FDB               STATE = COMPLETE
     CTRL VLAN = 1000                           SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 0                           FAIL TIME = 0
     HELLO SEQ = 0
 -----------------------------------------------------------------------
Flush FDB EPSR: test  vid: 2
EPSR INFO: Send trap EPSR:test oldState:FAILED newState:COMPLETE
    nodeType:MASTER
EPSR test oldState:FAILED newState:COMPLETE
```

11. The master node receives the Ring-Up-Flush-FDB message on port 2

The master node receives the Ring-Up-Flush-FDB message back on its secondary port, because the packet traversed the whole ring. The master node ignores the message.

```
EPSR Port2 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
    00bb0100 00541fea 00000000 0000cd28 0619990b 00400106 03e80000
    00000000 cd280619 00000000 01000000

 EPSR Port2 Rx:
 -----------------------------------------------------------------------
          TYPE = RING-UP-FLUSH-FDB               STATE = COMPLETE
     CTRL VLAN = 1000                           SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 0                           FAIL TIME = 0
     HELLO SEQ = 0
 -----------------------------------------------------------------------
```

12. The master node transmits and receives Health messages

The master node continues transmitting and receiving Health messages for as long as the ring stays in a state of Complete.

```
Manager x900-48-A>
epsrHelloTimeout: EPSR test Hello Timer expired
EPSR Port1 Tx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
    00bb0100 00541eed 00000000 0000cd28 0619990b 00400105 03e80000
    00000000 cd280619 00010002 010000fb

 EPSR Port1 Tx:
 -----------------------------------------------------------------------
          TYPE = HEALTH                    STATE = COMPLETE
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                     FAIL TIME = 2
     HELLO SEQ = 251
 -----------------------------------------------------------------------
EPSR Port2 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
    00bb0100 00541eed 00000000 0000cd28 0619990b 00400105 03e80000
    00000000 cd280619 00010002 010000fb

 EPSR Port2 Rx:
 -----------------------------------------------------------------------
          TYPE = HEALTH                    STATE = COMPLETE
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                     FAIL TIME = 2
     HELLO SEQ = 251
 -----------------------------------------------------------------------
 .
 .
 .
```

Transit Node (Node B) Debug Output

The following debugging shows the same events as the previous section, but on the transit node instead of the master node. It starts with the ring established and in a state of Complete.

1. The transit node receives Health messages

The transit node receives Health messages on port 1, because that port is connected to the master node’s primary port. Note that in the System field, this output shows the MAC address of the source of the message—the master node in this case.

This is the packet shown in step 1 on page 36 of the master node debug output.

```
EPSR Port1 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
    00bb0100 00541f2a 00000000 0000cd28 0619990b 00400105 03e80000
    00000000 cd280619 00010002 010000be

 EPSR Port1 Rx:
 -----------------------------------------------------------------------
          TYPE = HEALTH                           STATE = COMPLETE
     CTRL VLAN = 1000                            SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                            FAIL TIME = 2
     HELLO SEQ = 190
 -----------------------------------------------------------------------
Manager 9924-B>
EPSR Port1 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
    00bb0100 00541f29 00000000 0000cd28 0619990b 00400105 03e80000
    00000000 cd280619 00010002 010000bf

 EPSR Port1 Rx:
 -----------------------------------------------------------------------
          TYPE = HEALTH                           STATE = COMPLETE
     CTRL VLAN = 1000                            SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                            FAIL TIME = 2
     HELLO SEQ = 191
 -----------------------------------------------------------------------
 .
 .
 .
Manager 9924-B>
EPSR Port1 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
    00bb0100 00541eef 00000000 0000cd28 0619990b 00400105 03e80000
    00000000 cd280619 00010002 010000f9

 EPSR Port1 Rx:
 -----------------------------------------------------------------------
          TYPE = HEALTH                           STATE = COMPLETE
     CTRL VLAN = 1000                            SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                            FAIL TIME = 2
     HELLO SEQ = 249
 -----------------------------------------------------------------------
```

2. Port 1 on the transit node goes down

The transit node detects that port 1 (between the transit node and the master node) has gone down. The transit node flushes its forwarding database, blocks port 1 for the data VLAN (to prevent a loop from forming when the master node comes back up), sends a Link-Down message towards the master node, sends a trap, and changes the EPSR state to Link-Down.

This is the packet shown in step 4 on page 38 of the master node debug output.

```
EPSR test, Port 1 port down
Flush FDB EPSR: test  vid: 2
Block EPSR:test port:1 VLAN:2
EPSR Port2 Tx:  00e02b00 00040000 cd24024f 8100e3e8 005caaaa 0300e02b
    00bb0100 00542484 00000000 0000cd24 024f990b 00400108 03e80000
    00000000 cd24024f 00000000 04000000

 EPSR Port2 Tx:
 -----------------------------------------------------------------------
          TYPE = LINK-DOWN                 STATE = LINK-DOWN
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-24-02-4f
    HELLO TIME = 0                     FAIL TIME = 0
     HELLO SEQ = 0
 -----------------------------------------------------------------------
EPSR INFO: Send trap EPSR:test oldState:LINK-UP newState:LINK-DOWN
    nodeType:TRANSIT
EPSR test oldState:LINK-UP newState:LINK-DOWN
```

3. The transit node receives a Ring-Down-Flush-FDB message.

In response to the Link-Down message, the master node sends a Ring-Down-Flush-FDB message. However, this transit node does not need to flush its database—it already did.

This is the packet shown in step 5 on page 38 of the master node debug output.

```
EPSR Port2 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
    00bb0100 00541ee9 00000000 0000cd28 0619990b 00400107 03e80000
    00000000 cd280619 00000000 02000000

 EPSR Port2 Rx:
 -----------------------------------------------------------------------
          TYPE = RING-DOWN-FLUSH-FDB       STATE = FAILED
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 0                     FAIL TIME = 0
     HELLO SEQ = 0
 -----------------------------------------------------------------------
```

4. Port 1 comes back up

The transit node detects that port 1 has come back up. It sends a trap and changes the EPSR state to Pre-forwarding. Note that it leaves port 1 blocked for vlan2, to make sure there are no loops.

```
Manager 9924-B>
Block EPSR:test port:1 VLAN:2
EPSR test, Port 1 port up
EPSR INFO: Send trap EPSR:test oldState:LINK-DOWN newState:PRE-FORWARDING
    nodeType:TRANSIT
EPSR test oldState:LINK-DOWN newState:PRE-FORWARDING
```

5. Transit node receives a Health message

Now that the master node's primary port is up again, it sends a Health message. Now that the transit node's port 1 is up again for the control VLAN, the transit node receives the message. This demonstrates that the transit node has only blocked port 1 for the data VLAN, not the control VLAN. EPSR control messages never loop because the master node never forwards them between its ring ports.

Note that the hello sequence number increments from the number it was before the primary port went down, because the master node could not transmit Health messages while the port was down.

This is the packet shown in step 8 on page 39 of the master node debug output.

```
Manager 9924-B>
EPSR Port1 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
    00bb0100 00541dee 00000000 0000cd28 0619990b 00400105 03e80000
    00000000 cd280619 00010002 020000fa

 EPSR Port1 Rx:
 -----------------------------------------------------------------------
          TYPE = HEALTH                    STATE = FAILED
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                     FAIL TIME = 2
     HELLO SEQ = 250
 -----------------------------------------------------------------------
```

6. Transit node receives a Ring-Up-Flush-FDB message.

The Health message from the previous step reaches the master node and shows it that all links in the ring are now up. The master node sends a Ring-Up-Flush-FDB message. When it receives the message, the transit node unblocks port 1 for vlan2, flushes its FDB, sends a trap, and changes the state to Link-Up.

This is the packet shown in step 10 on page 40 of the master node debug output.

```
EPSR Port1 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
    00bb0100 00541fea 00000000 0000cd28 0619990b 00400106 03e80000
    00000000 cd280619 00000000 01000000

 EPSR Port1 Rx:
 -----------------------------------------------------------------------
          TYPE = RING-UP-FLUSH-FDB         STATE = COMPLETE
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 0                     FAIL TIME = 0
     HELLO SEQ = 0
 -----------------------------------------------------------------------
Unblock EPSR:test port:1 VLAN:2
Flush FDB EPSR: test  vid: 2
EPSR INFO: Send trap EPSR:test oldState:PRE-FORWARDING newState:LINK-UP
    nodeType:TRANSIT
EPSR test oldState:PRE-FORWARDING newState:LINK-UP
```

7. The transit node receives Health messages

The transit node continues receiving Health messages for as long as the ring stays in a state of Complete.

This is the packet shown in step 12 on page 41 of the master node debug output.

```
Manager 9924-B>
EPSR Port1 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
    00bb0100 00541eed 00000000 0000cd28 0619990b 00400105 03e80000
    00000000 cd280619 00010002 010000fb

 EPSR Port1 Rx:
 ----------------------------------------------------------------------
          TYPE = HEALTH                        STATE = COMPLETE
     CTRL VLAN = 1000                         SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                         FAIL TIME = 2
     HELLO SEQ = 251
 ----------------------------------------------------------------------
Manager 9924-B>
EPSR Port1 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
    00bb0100 00541eec 00000000 0000cd28 0619990b 00400105 03e80000
    00000000 cd280619 00010002 010000fc

 EPSR Port1 Rx:
 ----------------------------------------------------------------------
          TYPE = HEALTH                        STATE = COMPLETE
     CTRL VLAN = 1000                         SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                         FAIL TIME = 2
     HELLO SEQ = 252
----------------------------------------------------------------------
   .
   .
   .
```

Link Down Between Two Transit Nodes

This section shows the debugging output when the link between transit node B and transit node C goes down and comes back up again. It shows the debugging output for the complete failure and recovery cycle:

- on the master node, and then
- on transit node B

Master Node (Node A) Debug Output

The following debugging output starts with the ring established and in a state of Complete.

1. The master node sends Health messages

Each time the Hello timer expires, the master node sends a Health message out its primary port (port 1). As long as the ring is in a state of Complete, it receives each Health message again on its secondary port (port 2).

```
Manager x900-48-A>
epsrHelloTimeout: EPSR test Hello Timer expired
EPSR Port1 Tx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
00bb0100 00541ea1 00000000 0000cd28 0619990b 00400105 03e80000 00000000
cd280619 00010002 01000147

 EPSR Port1 Tx:
 -----------------------------------------------------------------------
          TYPE = HEALTH                    STATE = COMPLETE
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                     FAIL TIME = 2
     HELLO SEQ = 327
 -----------------------------------------------------------------------
EPSR Port2 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
00bb0100 00541ea1 00000000 0000cd28 0619990b 00400105 03e80000 00000000
cd280619 00010002 01000147

 EPSR Port2 Rx:
 -----------------------------------------------------------------------
          TYPE = HEALTH                    STATE = COMPLETE
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                     FAIL TIME = 2
     HELLO SEQ = 327
 -----------------------------------------------------------------------
```

2. The link between the two transit nodes goes down

When the link goes down, the master node transmits a Health message but does not receive it on its secondary port.

```
Manager x900-48-A>
epsrHelloTimeout: EPSR test Hello Timer expired
EPSR Port1 Tx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
00bb0100 00541ea0 00000000 0000cd28 0619990b 00400105 03e80000 00000000
cd280619 00010002 01000148

 EPSR Port1 Tx:
 -----------------------------------------------------------------------
          TYPE = HEALTH                    STATE = COMPLETE
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                     FAIL TIME = 2
     HELLO SEQ = 328
 -----------------------------------------------------------------------
```

3. The master node receives a Link-Down message on its secondary port

The master node receives a Link-Down message, which tells it that a link in the ring is broken. This message came from the transit node on one side of the broken link.

```
EPSR Port2 Rx:  00e02b00 00040000 cd20f101 8100e3e8 005caaaa 0300e02b
00bb0100 00544726 00000000 0000cd20 f101990b 00400108 03e80000 00000000
cd20f101 00000000 04000000

 EPSR Port2 Rx:
 -----------------------------------------------------------------------
          TYPE = LINK-DOWN                 STATE = LINK-DOWN
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-20-f1-01
    HELLO TIME = 0                     FAIL TIME = 0
     HELLO SEQ = 0
 -----------------------------------------------------------------------
```

4. The master node transmits a Ring-Down-Flush-FDB message

In response to the Link-Down message, the master node transmits a Ring-Down-Flush-FDB message out both its primary and secondary ports. The message has to go out both ports to make sure it reaches the nodes on both sides of the broken link. The master node also unblocks its secondary port for vlan2, flushes its forwarding database, sends a trap, and changes the EPSR state to Failed.

```
EPSR Port1 Tx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
00bb0100 00541ee9 00000000 0000cd28 0619990b 00400107 03e80000 00000000
cd280619 00000000 02000000

 EPSR Port1 Tx:
 ----------------------------------------------------------------------
          TYPE = RING-DOWN-FLUSH-FDB       STATE = FAILED
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 0                     FAIL TIME = 0
     HELLO SEQ = 0
 ----------------------------------------------------------------------
EPSR Port2 Tx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
00bb0100 00541ee9 00000000 0000cd28 0619990b 00400107 03e80000 00000000
cd280619 00000000 02000000

 EPSR Port2 Tx:
 ----------------------------------------------------------------------
          TYPE = RING-DOWN-FLUSH-FDB       STATE = FAILED
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 0                     FAIL TIME = 0
     HELLO SEQ = 0
 ----------------------------------------------------------------------
Unblock EPSR:test port:2 VLAN:2
Flush FDB EPSR: test  vid: 2
EPSR INFO: Send trap EPSR:test oldState:COMPLETE newState:FAILED
    nodeType:MASTER
EPSR test oldState:COMPLETE newState:FAILED
```

5. The master node receives a second Link-Down message

The master node receives a Link-Down message from the transit node on the other side of the broken link. This message arrived after a delay because the ring ports are 1000M ports (see "Ports and Recovery Times" on page 30). The master node does not take any action in response to this message, because it already responded to the broken link.

```
Manager x900-48-A>
EPSR Port1 Rx:  00e02b00 00040000 cd24024f 8100e3e8 005caaaa 0300e02b
00bb0100 00542484 00000000 0000cd24 024f990b 00400108 03e80000 00000000
cd24024f 00000000 04000000

 EPSR Port1 Rx:
 ----------------------------------------------------------------------
          TYPE = LINK-DOWN                 STATE = LINK-DOWN
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-24-02-4f
    HELLO TIME = 0                     FAIL TIME = 0
     HELLO SEQ = 0
 ----------------------------------------------------------------------
```

6. The master node continues sending Health messages

The master node continues sending Health messages out its primary port. It does not receive any of these at the secondary port, which tells it that the link is still down.

```
Manager x900-48-A>
epsrHelloTimeout: EPSR test Hello Timer expired
EPSR Port1 Tx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
00bb0100 00541d9f 00000000 0000cd28 0619990b 00400105 03e80000 00000000
cd280619 00010002 02000149

 EPSR Port1 Tx:
 ----------------------------------------------------------------------
          TYPE = HEALTH                        STATE = FAILED
     CTRL VLAN = 1000                         SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                         FAIL TIME = 2
     HELLO SEQ = 329
 ----------------------------------------------------------------------
 •
 •
 •
```

7. The master node receives a Health message

The master node transmits a Health message and receives it at the secondary port. This indicates that the link is back up.

```
Manager x900-48-A>
epsrHelloTimeout: EPSR test Hello Timer expired
EPSR Port1 Tx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
00bb0100 00541d72 00000000 0000cd28 0619990b 00400105 03e80000 00000000
cd280619 00010002 02000176

 EPSR Port1 Tx:
 ----------------------------------------------------------------------
          TYPE = HEALTH                        STATE = FAILED
     CTRL VLAN = 1000                         SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                         FAIL TIME = 2
     HELLO SEQ = 374
 ----------------------------------------------------------------------
EPSR Port2 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
00bb0100 00541d72 00000000 0000cd28 0619990b 00400105 03e80000 00000000
cd280619 00010002 02000176

 EPSR Port2 Rx:
 ----------------------------------------------------------------------
          TYPE = HEALTH                        STATE = FAILED
     CTRL VLAN = 1000                         SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                         FAIL TIME = 2
     HELLO SEQ = 374
 ----------------------------------------------------------------------
```

8. The master node returns the ring to a state of Complete

Now that the ring is back up, the master node blocks its secondary port for the data VLAN, transmits a Ring-Up-Flush-FDB message, flushes its FDB, sends a trap, and changes the EPSR state to Complete.

```
Block EPSR:test port:2 VLAN:2
EPSR Port1 Tx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
00bb0100 00541fea 00000000 0000cd28 0619990b 00400106 03e80000 00000000
cd280619 00000000 01000000

 EPSR Port1 Tx:
 ----------------------------------------------------------------------
          TYPE = RING-UP-FLUSH-FDB         STATE = COMPLETE
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 0                     FAIL TIME = 0
     HELLO SEQ = 0
 ----------------------------------------------------------------------
Flush FDB EPSR: test  vid: 2
EPSR INFO: Send trap EPSR:test oldState:FAILED newState:COMPLETE
nodeType:MASTER
EPSR test oldState:FAILED newState:COMPLETE
```

9. The master node receives the Ring-Up-Flush-FDB message on port 2

The master node receives the Ring-Up-Flush-FDB message back on its secondary port, because the packet traversed the whole ring. The master node ignores the message.

```
EPSR Port2 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
00bb0100 00541fea 00000000 0000cd28 0619990b 00400106 03e80000 00000000
cd280619 00000000 01000000

 EPSR Port2 Rx:
 ----------------------------------------------------------------------
          TYPE = RING-UP-FLUSH-FDB         STATE = COMPLETE
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 0                     FAIL TIME = 0
     HELLO SEQ = 0
 ----------------------------------------------------------------------
```

10. The master node transmits and receives Health messages

The master node continues transmitting and receiving Health messages for as long as the ring stays in a state of Complete.

```
Manager x900-48-A>
epsrHelloTimeout: EPSR test Hello Timer expired
EPSR Port1 Tx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
00bb0100 00541e71 00000000 0000cd28 0619990b 00400105 03e80000 00000000
cd280619 00010002 01000177

 EPSR Port1 Tx:
 -----------------------------------------------------------------------
          TYPE = HEALTH                    STATE = COMPLETE
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                     FAIL TIME = 2
     HELLO SEQ = 375
 -----------------------------------------------------------------------
EPSR Port2 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
00bb0100 00541e71 00000000 0000cd28 0619990b 00400105 03e80000 00000000
cd280619 00010002 01000177

 EPSR Port2 Rx:
 -----------------------------------------------------------------------
          TYPE = HEALTH                    STATE = COMPLETE
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                     FAIL TIME = 2
     HELLO SEQ = 375
 -----------------------------------------------------------------------
 .
 .
 .
```

Transit Node (Node B) Debug Output

The following debugging shows the same events as the previous section, but on the transit node instead of the master node. It starts with the ring established and in a state of Complete.

1. The transit node receives Health messages

The transit node receives Health messages on port 1, because that port is connected to the master node's primary port. Note that the message shows that the ring state is Complete.

This is the packet shown in step 1 on page 47 of the master node debug output.

```
Manager 9924-B>
EPSR Port1 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
00bb0100 00541ea1 00000000 0000cd28 0619990b 00400105 03e80000 00000000
cd280619 00010002 01000147

 EPSR Port1 Rx:
 -----------------------------------------------------------------------
          TYPE = HEALTH                    STATE = COMPLETE
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                     FAIL TIME = 2
     HELLO SEQ = 327
 -----------------------------------------------------------------------
 .
 .
 .
```

2. The link between the two transit nodes goes down

The transit node receives Health message 328. At this stage, the message does not indicate that anything is wrong. However, between messages 327 and 328, the link went down. This means that message 328 will not make it back to the master node.

This is the packet shown in step 2 on page 48 of the master node debug output.

```
Manager 9924-B>
EPSR Port1 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
00bb0100 00541ea0 00000000 0000cd28 0619990b 00400105 03e80000 00000000
cd280619 00010002 01000148

 EPSR Port1 Rx:
 -----------------------------------------------------------------------
          TYPE = HEALTH                    STATE = COMPLETE
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                     FAIL TIME = 2
     HELLO SEQ = 328
 -----------------------------------------------------------------------
```

3. The transit node receives a Ring-Down-Flush-FDB message

In the meanwhile, the master node has received a Link-Down message from the switch at the other end of the broken link (in step 3 on page 48). Therefore, the master node realises that the ring is broken and acts accordingly. As part of the recovery process, the master node sends a Ring-Down-Flush-FDB message. The transit node receives this message and flushes its forwarding database.

This is the packet shown in step 4 on page 49 of the master node debug output.

```
EPSR Port1 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
00bb0100 00541ee9 00000000 0000cd28 0619990b 00400107 03e80000 00000000
cd280619 00000000 02000000

 EPSR Port1 Rx:
 ----------------------------------------------------------------------
          TYPE = RING-DOWN-FLUSH-FDB       STATE = FAILED
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 0                     FAIL TIME = 0
     HELLO SEQ = 0
 ----------------------------------------------------------------------
Flush FDB EPSR: test  vid: 2
```

4. The transit node sends a Link-Down message

The transit node realises that its port is down, sends a Link-Down message, sends a trap, and changes its state to Link-Down. The transit node sends this message some time after the link actually went down, because the ring ports are 1000M ports (see "Ports and Recovery Times" on page 30). Note that by this stage the ring has already changed topology to restore traffic flow. The master node detected the link failure by receiving a Link-Down message from the other side of the link.

This is the Link-Down message that the master switch received in step 5 on page 49.

```
Manager 9924-B>
EPSR test, Port 2 port down
Flush FDB EPSR: test  vid: 2
Block EPSR:test port:2 VLAN:2
EPSR Port1 Tx:  00e02b00 00040000 cd24024f 8100e3e8 005caaaa 0300e02b
00bb0100 00542484 00000000 0000cd24 024f990b 00400108 03e80000 00000000
cd24024f 00000000 04000000

 EPSR Port1 Tx:
 ----------------------------------------------------------------------
          TYPE = LINK-DOWN                 STATE = LINK-DOWN
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-24-02-4f
    HELLO TIME = 0                     FAIL TIME = 0
     HELLO SEQ = 0
 ----------------------------------------------------------------------
EPSR INFO: Send trap EPSR:test oldState:LINK-UP newState:LINK-DOWN
nodeType:TRANSIT
EPSR test oldState:LINK-UP newState:LINK-DOWN
```

5. The transit node receives Health messages

The transit node receives Health messages from the master node. These have a state of Failed, which shows that the ring is still broken.

This is the packet shown in step 6 on page 50 of the master node debug output.

```
Manager 9924-B>
EPSR Port1 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
00bb0100 00541d9f 00000000 0000cd28 0619990b 00400105 03e80000 00000000
cd280619 00010002 02000149

 EPSR Port1 Rx:
 ----------------------------------------------------------------------
          TYPE = HEALTH                          STATE = FAILED
     CTRL VLAN = 1000                           SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                           FAIL TIME = 2
     HELLO SEQ = 329
 ----------------------------------------------------------------------
 .
 .
 .
```

6. The link comes back up

The transit node detects that the broken link has come back up. It blocks the port to prevent a loop from occurring, sends a trap, and changes the EPSR state to Pre-forwarding.

```
Manager 9924-B>
Block EPSR:test port:2 VLAN:2
EPSR test, Port 2 port up
EPSR INFO: Send trap EPSR:test oldState:LINK-DOWN newState:PRE-FORWARDING
nodeType:TRANSIT
EPSR test oldState:LINK-DOWN newState:PRE-FORWARDING
```

7. The transit node receives another Health message

The transit node receives another Health message. This message will make it back to the master node's secondary port, because the link between the two transit nodes is now up.

This is the packet shown in step 7 on page 50 of the master node debug output.

```
Manager 9924-B>
EPSR Port1 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
00bb0100 00541d72 00000000 0000cd28 0619990b 00400105 03e80000 00000000
cd280619 00010002 02000176

 EPSR Port1 Rx:
 ----------------------------------------------------------------------
          TYPE = HEALTH                          STATE = FAILED
     CTRL VLAN = 1000                           SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                           FAIL TIME = 2
     HELLO SEQ = 374
 ----------------------------------------------------------------------
```

8. The transit node receives a Ring-Up-Flush-FDB message

The transit node receives a Ring-Up-Flush-FDB message, which indicates that the master node knows that all links in the ring are up again. The transit node unblocks port 2 for vlan2, flushes its FDB, sends a trap, and changes state to Link-Up.

This is the packet shown in step 8 on page 51 of the master node debug output.

```
EPSR Port1 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
00bb0100 00541fea 00000000 0000cd28 0619990b 00400106 03e80000 00000000
cd280619 00000000 01000000

 EPSR Port1 Rx:
 ----------------------------------------------------------------------
          TYPE = RING-UP-FLUSH-FDB         STATE = COMPLETE
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 0                     FAIL TIME = 0
     HELLO SEQ = 0
 ----------------------------------------------------------------------
Unblock EPSR:test port:2 VLAN:2
Flush FDB EPSR: test  vid: 2
EPSR INFO: Send trap EPSR:test oldState:PRE-FORWARDING newState:LINK-UP
nodeType:TRANSIT
EPSR test oldState:PRE-FORWARDING newState:LINK-UP
```

9. The transit node receives Health messages

The transit node continues receiving Health messages for as long as the ring stays in a state of Complete.

This is the packet shown in step 10 on page 52 of the master node debug output.

```
Manager 9924-B>
EPSR Port1 Rx:  00e02b00 00040000 cd280619 8100e3e8 005caaaa 0300e02b
00bb0100 00541e71 00000000 0000cd28 0619990b 00400105 03e80000 00000000
cd280619 00010002 01000177

 EPSR Port1 Rx:
 ----------------------------------------------------------------------
          TYPE = HEALTH                    STATE = COMPLETE
     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-28-06-19
    HELLO TIME = 1                     FAIL TIME = 2
     HELLO SEQ = 375
 ---------------------------------------------------------------------
  .
  .
  .
```

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